REMARKS

Applicants are quite well acquainted with the cited references, WO 0005013 to Vaculik et al which is commonly owned with the Application by Dofasco Inc. Vaculik describes a multivariate statistical monitoring method for a continuous casting process in the steelmaking industry. However, it focuses merely on monitoring of one operating regime a steady-state casting operation and detecting possible breakouts during the steady-state casting operation. In contrast, the Application addresses a totally different operating regime in a continuous steel casting process: the startup operation. A series of inventive concepts and procedures have been developed in order to solve several new challenging problems during the startup operation, which are disclosed in the Application.

In this response document, applicants will first clarify significant differences between the steady-state casting operation and startup operation, and then identify the inventive concepts and procedures disclosed in the Application.

1. To clarify the difference between steady-state casting operation and startup operation.

The continuous caster is used to solidify molten steel into a semi-finished solid steel product such as a billet, bloom, or slab for subsequent rolling in a hot strip mill or a finishing mill. The entire operation sequence of this process consists of a brief start-up operation, followed by a prolonged continuous, steady-state casting operation, and finally a shut-down operation. The entire operation sequence is illustrated in the following figure, where the startup operation is indicated by A and the continuous, steady-state casting operation is indicated by B.

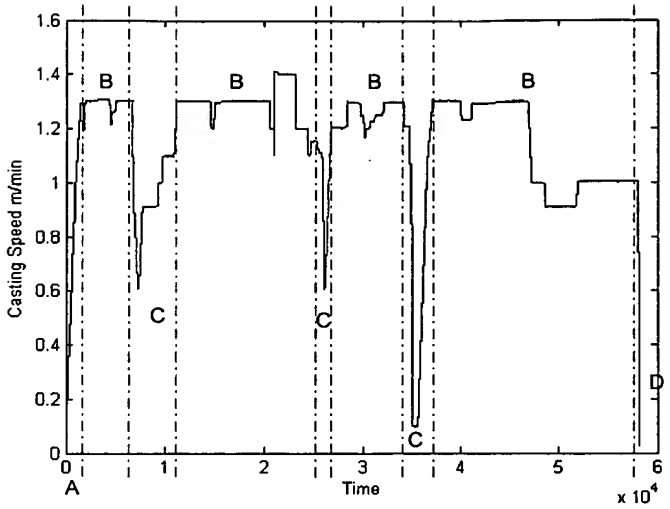

Figure 1. Continuous Caster Operating Regimes: A-Startup operation; B-Continuous steady-state casting operation; C-Transient operation (including SEN change, flying tundish change, etc., which are out of the scope of this discussion); D-Shutdown operation.

The differences between the steady-state casting operation and the startup operation are clearly defined as follows:

A. The startup operation refers to the very beginning of the operation (approximately 10 to 15 minutes), which initiates the casting process from the state of pouring liquid steel into an empty mould to achieve a stable operation. During the startup operation, the casting speed is continuously ramping up from zero m/min to a desired speed level, for example, 1.2 m/min whereas the steady-state casting operation follows the startup operation, during which the volume of liquid steel within the mould remains constant (i.e., constant mould level of liquid steel) and the process is controlled within a desired, steady-state operating zone. Although the casting speed may be changed during the continuous, steady-state casting operation, such changes are relatively small and are primarily used to maintain the mass flow through the caster. They don't move the process out of the steady-state operating zone.

B. The startup operation is essentially a dynamic process, during which the process dynamics are significantly changed over time due to the acceleration of casting speed whereas the steady-state casting operation is in fact a static process, or more strictly pseudo-static process. The difference between the startup operation

and steady-state casting operation can be demonstrated in the following two figures:

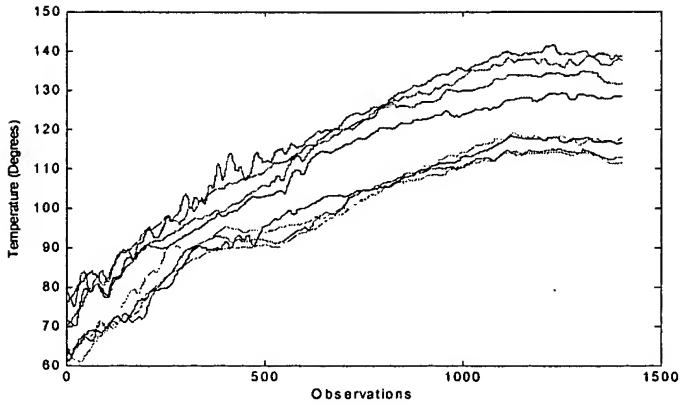

Figure 2. Process trajectory of example mould thermocouple temperatures during startup operation.

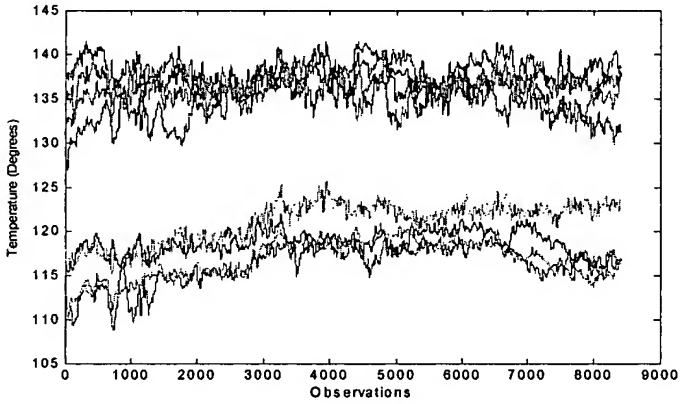

Figure 3. Process trajectory of example mould thermocouple temperatures during steady-state casting operations.

C. Most importantly, the nature of process measurements (i.e., process data) during the startup operation and steady-state casting operation are different. As shown in the above figures, the process measurements at each sample interval during startup operation are highly auto-correlated; whereas, the process measurements at each sample interval during the steady-state casting operation can be considered independent from each other. Vaculik WO 0005013 cannot successfully be applied to the startup operation for online monitoring and breakout detection purposes.

2. To identify the inventive concepts and procedures in the current patent application.

The answers to the following questions are not obvious to those skilled in the art:
(1) how to mathematically define the start and end point of startup operation;
(2) how to synchronize the process trajectories if the duration of startup operation is different;
(3) how to monitor a dynamic process with auto-correlated process data during a startup operation; and
(4) how to successfully detect the onset of a breakout and other abnormal operating situations during startup operations.

In the Application, inventive concepts and procedures were disclosed to solve the above problems, including: (1) the duration of a startup operation is defined based on the casting speed as well as the strand length; (2) a systematic procedure is proposed to synchronize process trajectories based on non-uniform synchronization scales defined in the strand length; (3) a multi-way principal component analysis model is developed to monitor the dynamic process during the startup operation; etc. These new concepts and procedures are described in great detail in the Application.

It is worth noting that the above concepts and procedures have been already applied to monitor startup operations of No.2 Continuous Caster at Dofasco Inc. This industrial application demonstrates a good ability to detect breakouts and other abnormal operating situations during start-up operations, hence demonstrating the utility of the invention.

3. Applicants' comments to the objections in the Office Action.

With respect to Examiner's objections in Section 2, the applicants have the following comments made particularly to the prior art cited.

A. International Publication Number: WO 00 05013 A), invented by Vit Vaculik, et al. of Dofasco Inc. Vit Vaculik is also one of the inventors of the current patent application. The cited document has been taken into consideration as a prior art work in the Application (see paragraph [009] in the section on Background Art). Although the cited document and the Application are both applied to the same industrial process and use similar process monitoring procedures to detect breakouts of a continuous caster, substantial differences exist between them that are described again as follows. Vaculik WO 0005013 focuses on detection of

breakouts that occur during a continuous, steady-state casting operation, particularly when a continuous caster is operating at a predetermined casting speed (in a preferred embodiment, for example, the speed range is from 600 mm/min to the maximum recorded speed). By contrast, the Application targets the detection of breakouts that occur within a short, definite duration of a continuous caster start-up operation, during which the casting speed is continuously increasing from zero mm/min to a defined end point. To perform the detection described in the current patent application, a Multi-way Principal Component Analysis (MPCA) method is adopted, which includes a special data treatment procedure (i.e., process trajectory synchronization) to capture the process dynamics of start-up operations. Such a procedure of data treatment is not done in Vaculik WO 0005013.

As indicated above, there is no teaching in Vaculik WO 0005013 of determining the duration of a start-up operation and synchronizing the process trajectories during the start-up operation with respect to a pre-determined set of non-uniform synchronization scales in the strand length and performing MPCA calculations to monitor the dynamic caster start-up operation, respectively.

System Claims 15 to 19 are amended so that they are not dependent on a method Claim.

Reconsideration of Claims 1 to 19 is respectfully requested.

Respectfully submitted,

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